Space Weather Technical Forecast

Issued on Wednesday 1 January 2025 at 13:26 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

Space Weather Forecast Headline: R1/R2 Radio Blackouts expected with a slight chance of R3 blackouts. Ongoing influence from a CME sees G1-G2 Minor/Moderate storm conditions likely, with a slight chance of G3 Strong storm.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with three M-class flares during the past 24 hours, the peak being an M2.9 flare from AR3938 at 31/2250 UTC. AR3936 also produced a long duration flare, peaking at M2.7 at 31/2218 UTC.

There are currently ten sunspot regions on the Earth-facing disc. AR3936 in the northwest remains the largest and most complex region, but is now becoming harder to analyse as it approaches the western limb. AR3939 appears to have gained complexity, with a possibly very small and weak delta within its trailing spots. AR3938 and AR3941 are moderately complex but have remained much unchanged in recent imagery. AR3944, a unnumbered region in the southwest and the newly numbered AR3945 on the eastern limb have all shown growth in the last 24 hours. The remaining regions are small and magnetically simple.

A possible filament lift off near AR3939 is undergoing further analysis to diagnose any Earth-directed material.

Solar Wind / Geomagnetic Activity: The first CME arrived at Earth at 31/1626 UTC with the second CME arriving at Earth by 01/0215 UTC. Solar wind speeds, as observed at L1 by ACE and DSCOVR initially were at background levels around 350-380km/s soon increasing to around 450km/s with the arrival of the first CME, then the second CME saw winds increase again, this time to elevated levels around 520km/s. Density was generally below average before any CME arrivals becoming above average with a peak of 58ppcm at 01/0813 UTC. The Interplanetary Magnetic Field (IMF) was Moderate quickly rising to Strong with the initial CME arrival, slowly dipping back to Moderate before rising again to Strong for the second CME. Peaking at 27nT at 31/1735 UTC. The north-south component was often negative ranging from -23nT at 01/1020 UTC to +13nT at 01/0606 UTC. The Phi angle was largely positive (away from the Sun) until 01/0440 UTC when it became negative (towards the Sun). Geomagnetic activity increase from Quiet (Kp1) to G2 Moderate storm (Kp6) by the end of the period.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 remained at background throughout, well below the S1/Minor Radiation Storm threshold.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

High energy electron flux (greater than 2MeV) at GOES16 was at mainly at Background levels, diurnally increasing to Moderate levels, peaking at 31/1715 UTC at 507pfu. The associated 24-hour fluence was below the Active (1e8 integrated flux) threshold on a slightly increasing trend. The 31/0001UTC observation was 4.68e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Moderate solar activity is forecast with isolated M-class flares likely, and a slight but declining chance of isolated X-class flares, mainly from AR3936 which will rotate onto the far side through the forecast period.

Solar Wind / Geomagnetic Activity: Ongoing influence from the two partial halo CMEs that arrived on 31 Dec and early hours (UTC) of the 01 Jan will gradually wane through 01 Jan. There are no other Earth-directed CMEs in the forecast. By the end of the period we may see some enhancement from a HSS originating from CH05+.

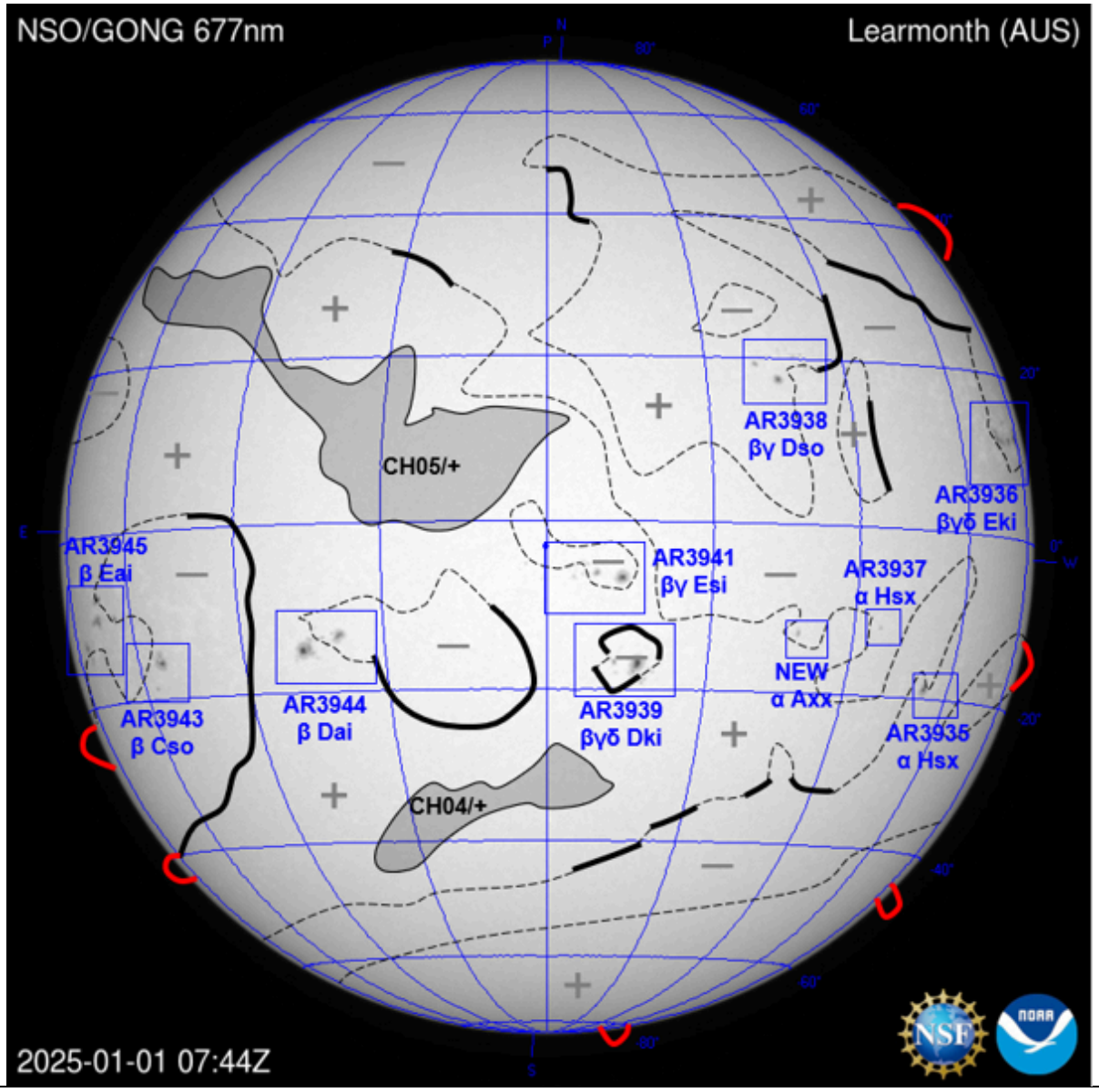
Initially geomagnetic activity is likely to be G1/G2 Minor to Moderate (Kp5-6) with a slight chance of G3 Strong (Kp7) storm intervals, this is expected to ease to Unsettled (Kp3) with a chance of G1/G2 Minor-Moderate storms by Day 2 (02 Jan) and eventually it is expected to become Quiet to Unsettled by Day 3 (03 Jan) (Kp0-3).

Energetic Particles / Solar Radiation: There is a slight chance of S1/Minor Radiation Storm enhancements during the period from any significant flares, initially most likely from AR3936 and AR3938. Electron flux levels are expected to remain at Background to Moderate. Electron fluence will is expected to persist below the Active threshold.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

Figure 1: Solar Synoptic Map valid 01/0744 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

Geomagnetic Storms

The influence from the two partial halo CMEs that left the Sun on 29 Dec from the southeast disc will gradually wane through the course of Day 1 (01 Jan) and geomagnetic activity is expected to slowly return to Quiet to Unsettled conditions. A possible filament lift off near AR3939 is undergoing further analysis to diagnose any Earth-directed material.

CH05+ is a persistent feature and on the previous rotation brought a connection to a high speed stream and elevated solar winds of 500-550km/s. This resulted in intervals of Unsettled to Active geomagnetic activity. Similar conditions are expected from this recurring feature but not expected until Day 4 (04 Jan).

Initially geomagnetic activity is likely to be G1/G2 Minor to Moderate with a slight chance of G3 Strong storm intervals, this is expected to ease to Unsettled with a chance of G1/G2 Minor-Moderate storms by Day 2 (02 Jan) and eventually it is expected to become Quiet to Unsettled by Day 3 (03 Jan).

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	60	30	5	10
Strong	G3	No	5	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
2024-12-29 (2310 UTC)	Partial	AR3939	Southeast	697 km/s	2025-01-01 (0900UTC)	M3.3 flare from AR3939

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

Figure 2: MOSWOC Enlil output

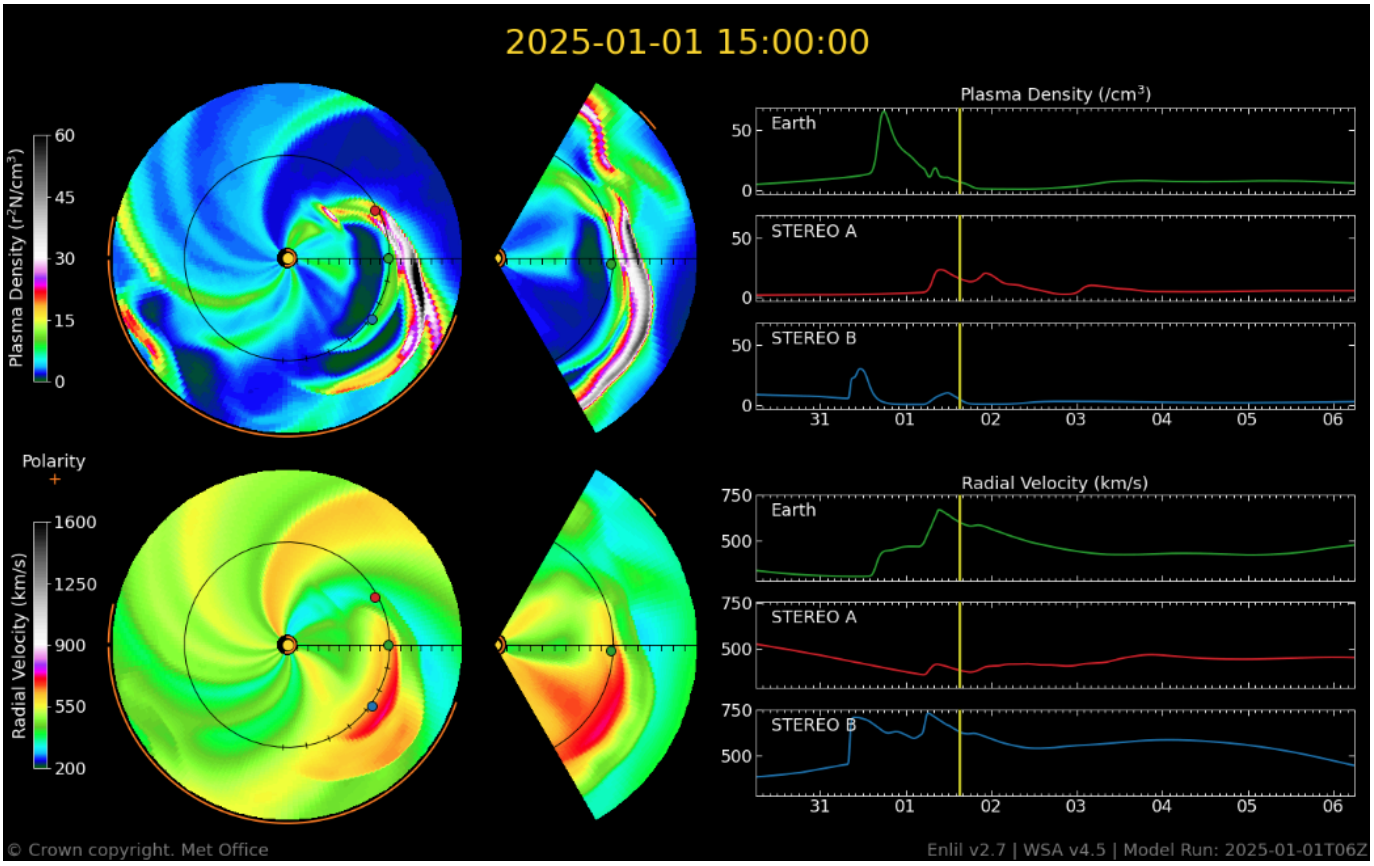
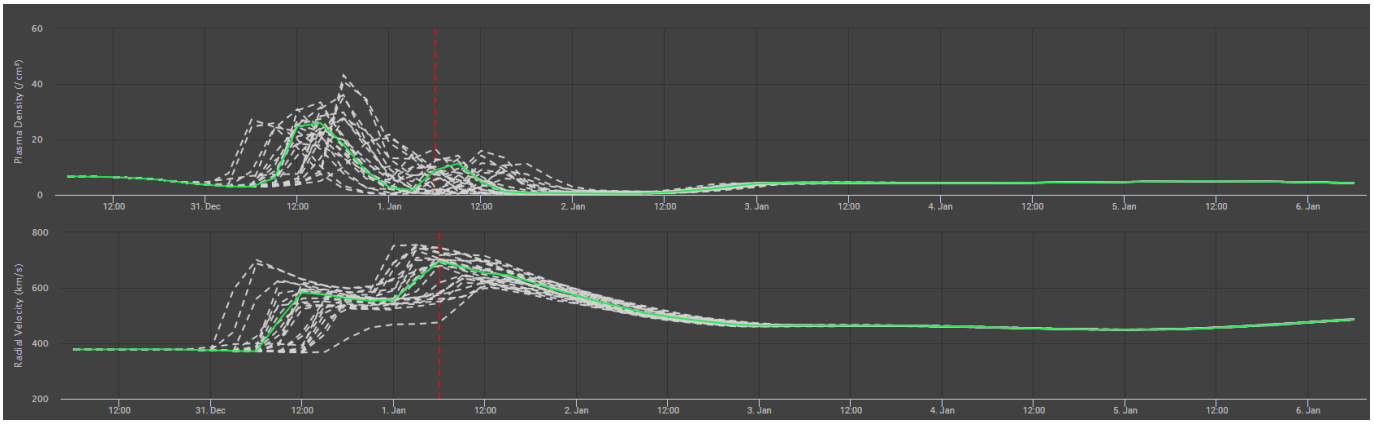


Figure 3: MOSWOC Ensemble output.



© Crown Copyright 2025. All Rights Reserved.

Radio Blackouts - X-Ray Flares

There are currently ten sunspot regions on the Earth-facing disc. AR3936 in the northwest remains the largest and most complex region, but is now becoming harder to analyse as it approaches the western limb. The previous classification has been retained, but with low confidence. AR3939 appears to have gained complexity, with a possibly very small and weak delta within its trailing spots. AR3944 continues to show moderate growth, in both the size of the leading and trailing spots and in the development of some smaller intermediate spots. A new region has developed in the southwest, currently unnumbered, but has quickly spun up to a small bipolar region. As AR3943 has continued to rotate into a better viewing angle, it has become clearer to ascertain that there are two separate regions here, so a newly numbered region, AR3945 has been identified following behind it. This region appears to be developing as it rotates onto the visible disc. The remaining regions are small and magnetically simple.

Recent GOES-16 SUVI 171 imagery shows the snapping of magnetic field lines in the northeast which may indicate an active sunspot region to shortly come around the eastern limb in the coming days. Far-sided data also supports this theory. This helps to maintain a chance of M-class flares through the period, even with the loss of AR3936 around the western limb.

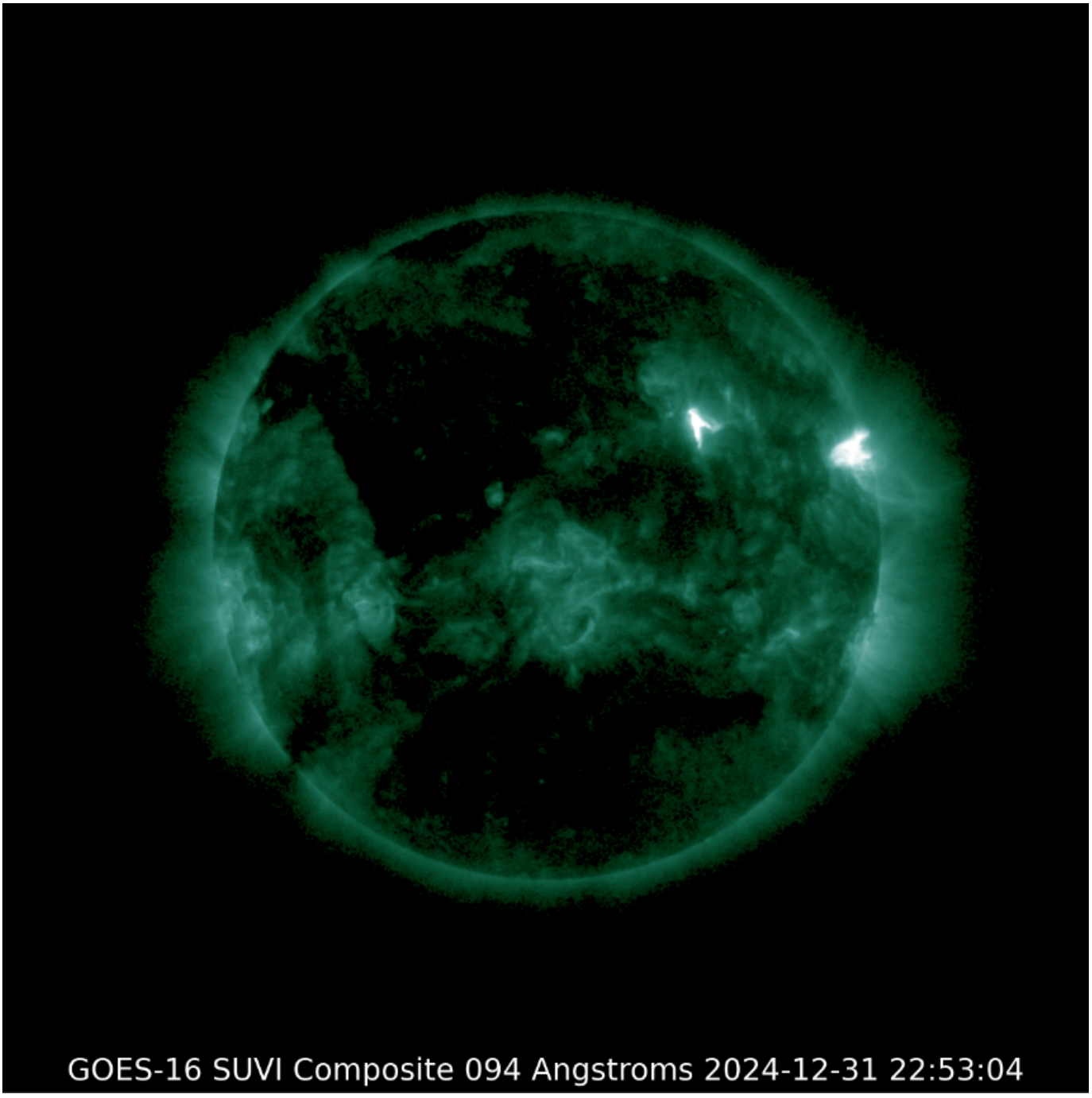
Moderate solar activity is forecast with isolated Moderate flares likely and a slight chance of isolated X-class flares, especially from AR3936. However, as this region will rotate off behind the west limb during the period so the chance of significant flares decreases.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	70	50	40	40
Very Active	R3-R5 (X Class)	No	15	5	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

Figure 4: M-class flares from AR3936 and AR3938.



© Crown Copyright 2025. All Rights Reserved.

Figure 5: GOES 16 & 18 X-ray trace

© Crown Copyright 2025. All Rights Reserved.

Solar Radiation Storms (High Energy Protons)

High energy proton counts remain at Background values. There remains a slight chance of S1/Minor Solar Radiation storms should any significant flares occur from the larger regions in the western hemisphere, initially most likely from AR3936 and AR3938, then from AR3939 and AR3941.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

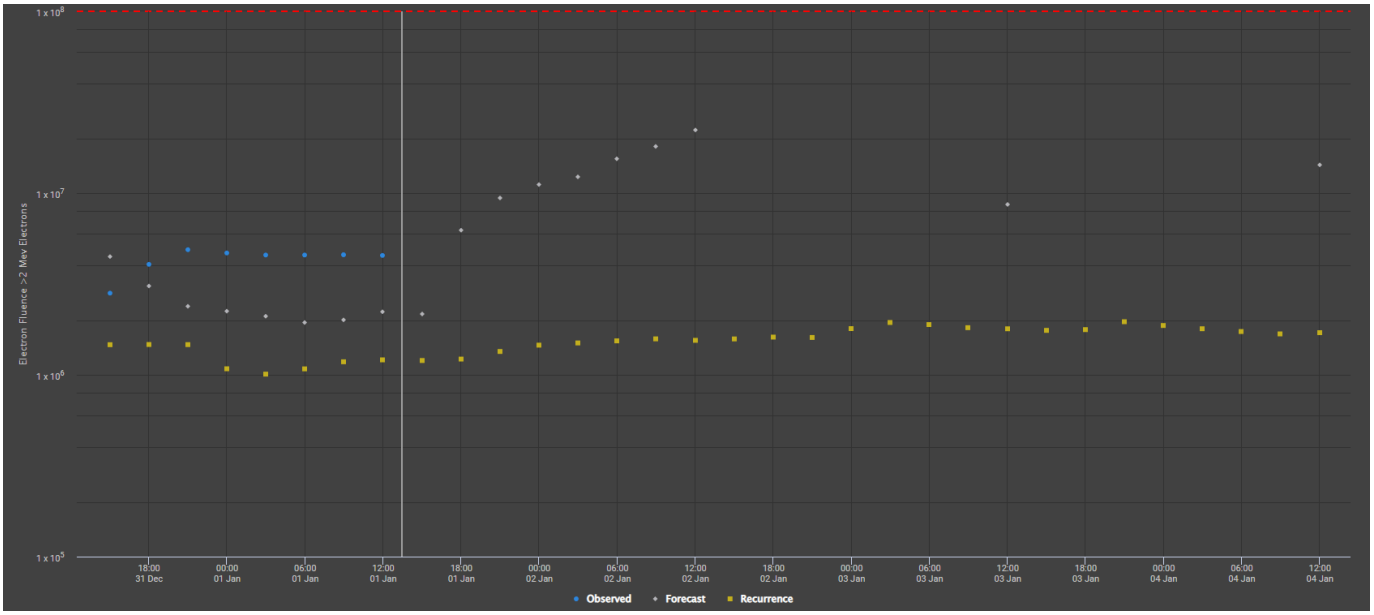
© Crown Copyright 2025. All Rights Reserved.

High Energy Electrons (≥ 2MeV)

High energy electron flux has remained at Background, with diurnal peaks up to Moderate levels in the last 24 hours. Electrons are likely to appear slightly suppressed due to the two CME arrivals on 31 Dec and 01 Jan, as a result of the Van Allen belt likely becoming compressed away from the location of GEO. This may expand once any geomagnetic activity has eased, seeing a rise in the electron levels. Electron fluence may also see a rise but is still expected to remain below the Active threshold throughout, as shown in MOSWOC REFM output, which is considered good guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	5	10	20	20
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 6: MOSWOC REFM output.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.